

# Field scale greenhouse gas emissions in a furrow-irrigated field under standard and minimum tillage

A.P. King<sup>1</sup>, D.E. Rolston<sup>1</sup>, J.W. Hopmans<sup>1</sup>, C. Van Kessel<sup>2</sup>, J. Six<sup>2</sup>, K.T. Paw U<sup>1</sup>, R.E. Plant<sup>2</sup>, T.C. Hsiao<sup>1</sup>, A.J. Ideris<sup>1</sup>, J. Kochendorfer<sup>1</sup>, J. Lee<sup>2</sup>, D. Louie<sup>1</sup>, J.L. MacIntyre<sup>1</sup>, A.A. Matista<sup>1</sup>, K.J. Evatt<sup>1</sup>



Departments of Land, Air and Water Resources<sup>1</sup> and Plant Sciences<sup>2</sup>, University of CA, Davis.



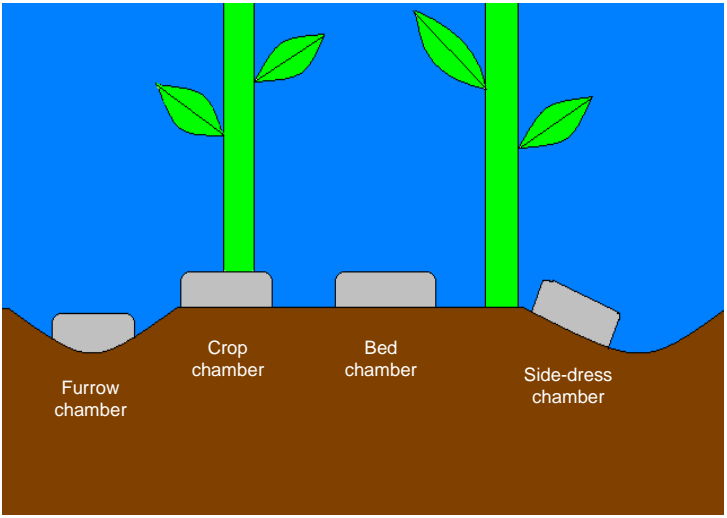
## MATERIALS AND METHODS

This greenhouse gas study is part of a multi-disciplinary study of C sequestration potential in CA agricultural systems. The field site is equipped with 3 suites of instruments for measuring CO<sub>2</sub> at multiple scales:



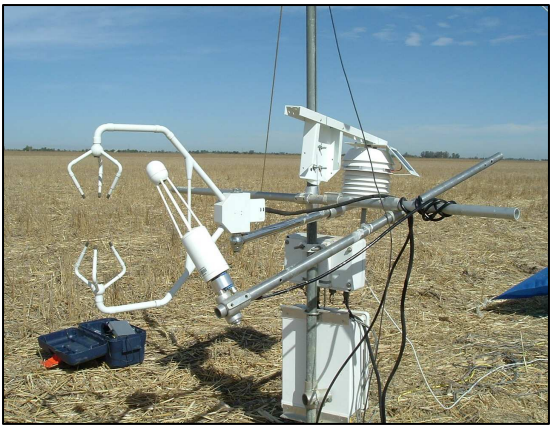
### Portable PVC Chambers for CO<sub>2</sub> and N<sub>2</sub>O

The portable chambers are made of 10" PVC rings permanently installed at locations that span both fields, and a portable PVC end-cap lid, which is attached to a Licor infrared gas analyzer (IRGA) for CO<sub>2</sub> measurement. N<sub>2</sub>O is sampled with a syringe from the vented chambers and brought back to the lab for analysis on a gas chromatograph. There are a maximum of 4 chambers at each sampling location, as shown here. Chambers are sampled regularly throughout the year.



### Automated Chambers

There are 2 chambers in the ST and 1 in the MT fields. They close for 1 minute every half hour, when fans mix the air in the chamber, and measure soil CO<sub>2</sub> flux with a Licor IRGA. They cover a 0.62 m<sup>2</sup> area, and are used to evaluate **temporal patterns** of CO<sub>2</sub> flux and soil temperature in the fields.



### Eddy Covariance Towers

There is a tower in each treatment, along the western transect. The towers measure CO<sub>2</sub> flux, as well as wind speed and direction, radiation from the ground and sky, relative humidity, air temperature, and soil heat flux. The towers provide frequent, field-scale measurements of net gas flux in the fields.

### Acknowledgements

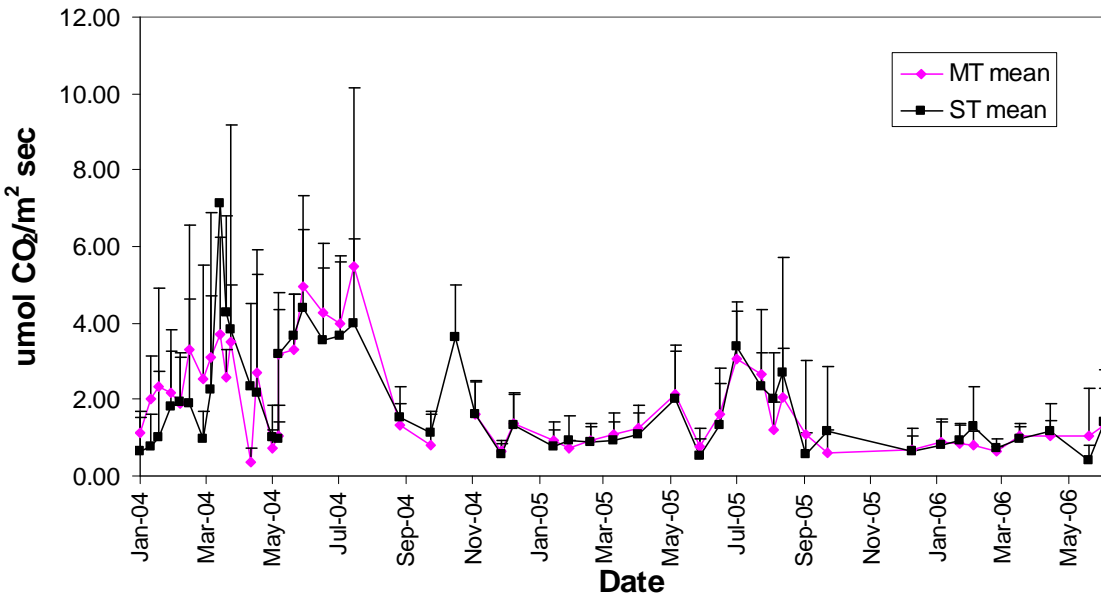
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## ABSTRACT

This study aimed to quantify CO<sub>2</sub> and N<sub>2</sub>O release from an irrigated field in California's Sacramento Valley in an effort to determine greenhouse gas mitigation potentials through minimum tillage (MT) practices. The 30 ha, laser-leveled field site was monitored with portable static chambers for CO<sub>2</sub> and N<sub>2</sub>O flux from the soil surface in standard tillage (ST) and MT treatments from September 2003 through August 2006. The field was also equipped with 2 eddy-covariance masts and 2 continuously sampling auto-chambers, to estimate total C budgets at the field scale and temporal changes in soil CO<sub>2</sub> flux, respectively. The crop grown on the field was different each year; the first year it was wheat, then corn, sunflower and chick peas. Overall, there was very little difference in CO<sub>2</sub> flux between the two tillage treatments. Flux numbers were highly spatially variable, well-correlated with air and soil temperature, and dependent on soil moisture and the degree of soil disturbance in the 2 tillage systems. Chambers placed over the crop roots showed higher CO<sub>2</sub> flux during the growing season due to root respiration, but did not differ significantly between the 2 treatments. N<sub>2</sub>O flux was negligible in both systems until a fertilization and irrigation event occurred in each growing season, at which point the MT treatment showed slightly higher fluxes. CO<sub>2</sub> and N<sub>2</sub>O data from this site is being used in several models that will enable us to predict greenhouse gas emissions from similar agricultural systems in the California landscape. Results from this site indicate that short-term MT may not significantly decrease the contribution to global warming by irrigated agroecosystems and thus may not be a beneficial strategy for greenhouse gas mitigation.

## RESULTS FROM PORTABLE CHAMBERS

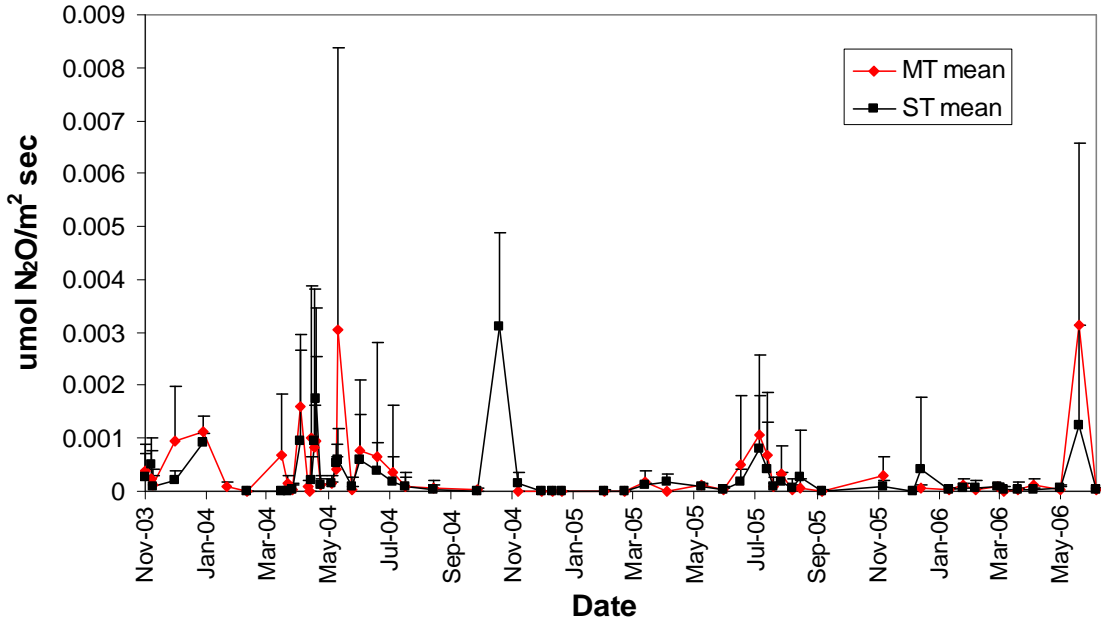
### CO<sub>2</sub> soil flux (Jan 04 – Jun 06)



CO<sub>2</sub> emissions were generally very similar between tillage treatments, although in 2004 MT often had higher soil respiration rates than the ST. This may be due to the presence of actively decomposing residue on the soil surface in a field only recently converted to MT.



### N<sub>2</sub>O soil flux (Nov 03 – Jun 06)



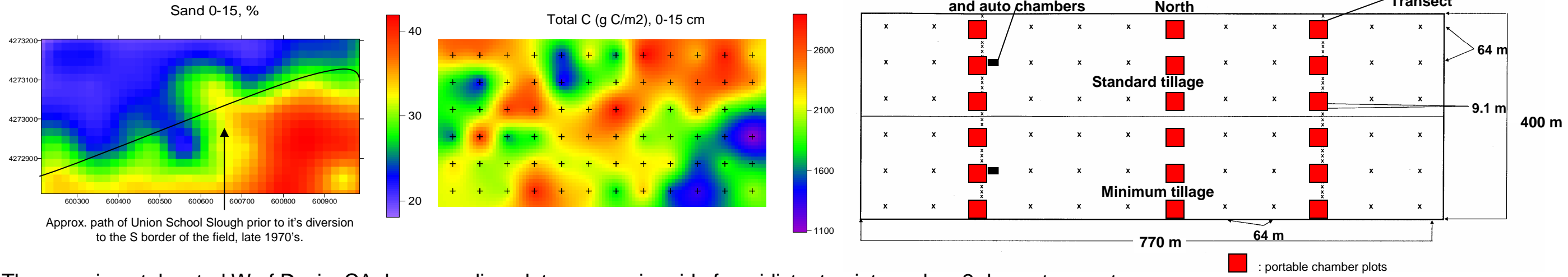
N<sub>2</sub>O emissions were generally low, but peaked when both fertilizer and irrigation water were applied. In 2004, when the MT treatment had been no-till for 2 years, MT N<sub>2</sub>O flux was higher. In subsequent seasons the 2 treatments were very similar, although MT flux remained higher on average.

### Global Warming Potential (GWP) of tillage treatments

	Minimum Till			Standard Till		
	CO <sub>2</sub>	N <sub>2</sub> O	Total GWP	CO <sub>2</sub>	N <sub>2</sub> O	Total GWP
2004	0.10	0.0055	<b>0.1055</b>	0.10	0.0053	<b>0.1053</b>
2005	0.058	0.0608	<b>0.0608</b>	0.059	0.0022	<b>0.0612</b>

All numbers are in MT CO<sub>2</sub> equivalents projected over 100 years from the 30 hectare field site, from the soil respiration data only. The two treatments are equivalent in total GWP for the years presented. Future analyses will incorporate the eddy covariance net flux data to get accurate C budgets for both treatments.

## Field Site and Experimental Design

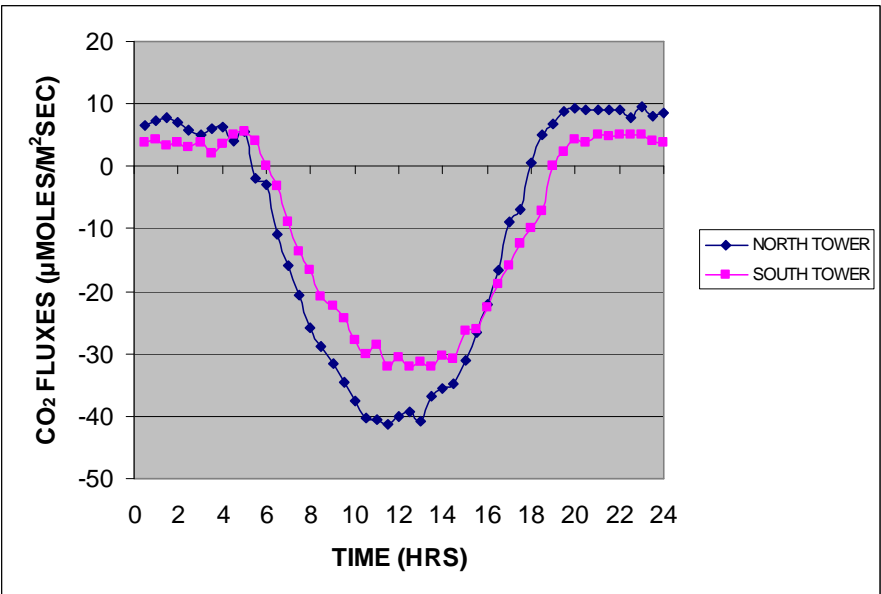


The experiment, located W of Davis, CA, has sampling plots on a main grid of equidistant points and on 2 dense transects. There is considerable heterogeneity in soil properties such as texture and C, shown above.



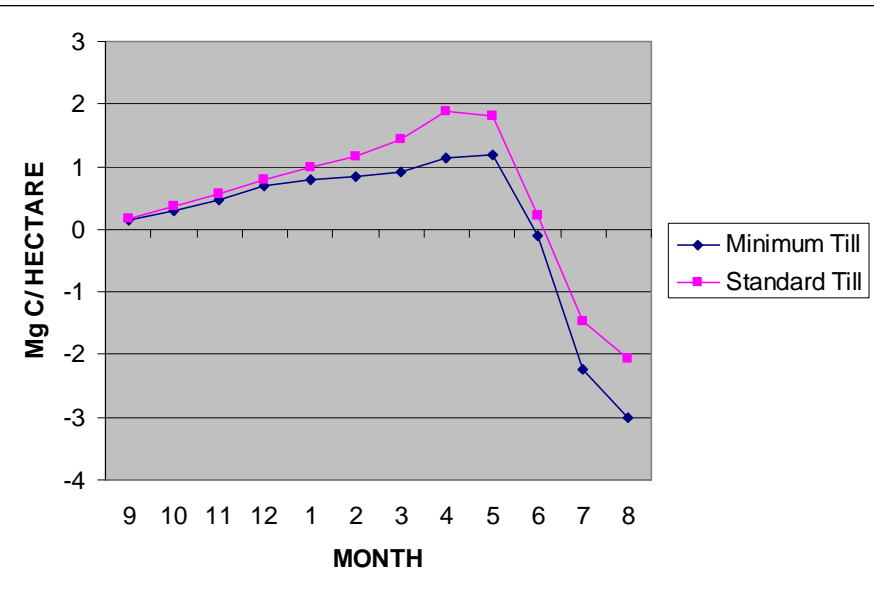
## EARLY RESULTS FROM EDDY COVARIANCE TOWERS

### CO<sub>2</sub> flux (May 04)



Decreased crop growth and subsequent yield in the MT corn crop was revealed in the net flux data, which shows the ST (North Tower) treatment taking up more CO<sub>2</sub> during the daylight hours. Nighttime respiration was higher in the ST treatment at this time.

### Net ecosystem exchange (Sep 03 – Aug 04)



This shows that the MT treatment (which had been no-till for 2 years at this point) did sequester more C, despite it's decreased yield compared to ST and higher measured soil flux rates.

## PRELIMINARY CONCLUSIONS:

- Surface soil respiration is not significantly different between tillage treatments unless the standard and minimum tillage operations are substantially different, as was the case in 2004, when MT flux rates exceeded those of ST.
- Given the very high global warming potential of N<sub>2</sub>O, even minor fluxes must be taken into account, and these are generally higher in the more anaerobic environments of minimum tillage fields.
- Net flux measured from the eddy covariance towers reveals that differences in crop growth patterns between tillage treatments can play a major role in the total C sequestration potential of each treatment. Future analyses will determine if NEE shows any treatment differences in the 2005 or 2006 seasons.
- Conversion to MT may not be a beneficial strategy for greenhouse gas reduction in CA.

## Timeline of field operations

